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TPCK in Inservice Education: Assisting Experienced Teachers' "Planned Improvisations"

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"Jazz today, as always in the past, is a matter of thoughtful creation, not mere unaided instinct."
- Duke Ellington

To an experienced educator, teaching is much like jazz performance: a well-practiced fusion of careful, creative planning and spontaneous improvisation. Like jazz music, much of good teaching is context-dependent, serendipitous improvisation, yet it still follows predetermined, somewhat predictable structures sequenced in virtually infinite permutations.[1] Functional and effective learning activity designs and implementation strategies for teachers' use must build upon such educational improvisation, so that students' needs, preferences, and reactions can be accommodated. Yet they must also be carefully planned, so that curriculum standards are addressed in appropriate ways within the time constraints of the school day and year. For even the experienced teacher, assisting students' learning "is a matter of thoughtful creation, not mere unaided instinct," as Mr. Ellington reminds us.

What happens when experienced teachers seek to integrate educational technologies into curriculum-based learning and teaching, and how can teacher educators assist this professional development process? This chapter will suggest answers to this question in both conceptual and practical forms, framed within the notion of technological pedagogical content knowledge development (Mishra & Koehler, 2006; Koehler & Mishra, chapter 1).

Technology Integration: A "Vamp"

"'Swing' is an adjective or a verb, not a noun. All jazz musicians should swing. There is no such thing as a 'swing band' in music."
-Artie Shaw

A "vamp" in jazz music is a brief, repeated chord progression, usually used to introduce a performance, like the piano chords that serve as a musical preamble to Frank Sinatra's famous

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[1] Sincere thanks are offered here to my colleague, Mark Hofer, for suggesting this metaphor and collaborating with me to construct its components.

"That's Life!" song. Technology integration is a vamp of sorts, in that it appears often in today's educational literature, but its definitional parameters, as expressed and implied currently--like Artie Shaw's notion of a "swing band" cited above--can be shallow (Pierson, 2001) and technocentric (Papert, 1987). Yet educational technologies, like Shaw's use of "swing" as an adjective or verb, may be applied appropriately in many types of teaching and learning. In doing so, they should assist with-–not overshadow—teachers helping students to meet curriculum-based standards.

Recent conceptions of technology integration (e.g., Gunter & Baumbach, 2004) focus upon curriculum-based, educational *uses* for digital tools and resources, rather than the affordances of the technologies themselves. As Earle (2002) asserts,

> Integrating technology is not about technology – it is primarily about content and effective instructional practices. Technology involves the tools with which we deliver content and implement practices in better ways. Its focus must be on curriculum and learning. Integration is defined not by the amount or type of technology used, but by how and why it is used. (p. 8)

For the purposes addressed in this chapter, I suggest a basic definition for technology integration: the pervasive and productive use of educational technologies for purposes of curriculum-based learning and teaching. Note that this definition does not specify or imply a particular educational approach, philosophy, or goal. More on this below.

Studies of K-12 teachers' instructional applications of educational technologies to date show many of the uses to be pedagogically unsophisticated; limited in breadth, variety, and depth; and not well integrated into curriculum-based teaching and learning (e.g., Cuban, 2001; Earle, 2002; McCrory-Wallace, 2004; Zhao, Pugh, Sheldon & Byers, 2002). In a 20-year retrospective on U.S. educational technology policy, Culp, Honey, and Mandinach (2003) describe a mismatch between educational technology leaders' visions for technology integration, and how most practitioners use digital tools, by saying:

> Technological innovations favored by the research community intended to support inquiry, collaboration, or re-configured relationships among students and teachers continue to be used by only a tiny percentage of America's teachers….Instead, teachers are turning to tools like presentation software, resources like student-friendly information sources on the Internet, and management tools like school-wide data systems to support and improve upon their existing practices… (p. 22).

McCormick & Scrimshaw (2001) label these currently predominant uses for information and communication technologies as "efficiency aids" and "extension devices," differentiating them from "transformative devices" (p. 31), which "transform the nature of a subject at the most fundamental level" (p. 47). These authors suggest that such curricular transformation happens only in those few content areas (e.g., music, literacy, and art) that are "largely defined by the media they use" (p. 47). (More on educational technologies as transformative devices in literacy and the arts can be found in chapters 3 and 8, respectively.)

Given this discrepancy between leaders' visions and practitioners' actions, perhaps teacher educators' choices among efficiency, extension, and transformative applications of educational technologies in professional development for experienced teachers should be strategic and context-dependent, rather than automatic and unilateral. In each unique professional development situation, a customized and collaborative decision about the nature of the approach could be made along with school stakeholders. In situations in which pervasive educational use of digital technologies is more important than transformative use, professional development can be designed to incorporate more efficiency- and extension-focused integration. In situations in which curricular transformation is sought, professional development can encourage transformative educational technology use.

Yet to date – and perhaps due to the largely transformative agendas of most organized technology integration efforts--persistent and pervasive technology integration in classroom practice has been notoriously difficult to sustain, and almost as challenging to catalyze. Two notable exceptions to this pattern, however, are instructive. In less than a decade, more than 90% of secondary mathematics classes in the U.S. have adopted use of graphing calculators (as described in chapter 7)--so pervasively that they are now required of students taking Advanced Placement exams (Bull & Garofalo, 2004). During an even shorter time period, WebQuests (Dodge, 1995) have pervaded elementary-level classrooms and Internet-related professional development for teachers in North America (March, 2003/2004; Molebash, n.d.). The keys to the rapid adoption rates for these particular curriculum-based uses for educational technologies are also key to successful, self-sustaining professional development for experienced teachers: recognizable *content, structure,* and *advantage.* Each of these factors will be addressed below.

TPCK Content: Jazz "Riffs"

"I'll play it first and tell you what it is later."
- Miles Davis

Jazz riffs are short, recognizable melodic phrases that are repeated within and across different songs. Some blues riffs, for example—like the melodic phrases that we associate with B.B. King playing his guitar "Lucille"--are so recognizable that even beginning musicians can use them to "jam." Other riffs are unique to particular performers and jazz traditions. Riffs can therefore be used to help more sophisticated listeners recognize and focus upon jazz musical characteristics, style, development, and innovations. In a sense, riffs express the "content" of jazz music in ways that help listeners to recognize and appreciate it.

Clearly, teachers need curriculum-related content knowledge to do their jobs effectively. Windschitl (2004) defines this as "understanding of a domain's concepts, theories, laws, principles, history, classic problems, and explanatory frameworks that organize and connect its major ideas." (A framework for thinking about teacher knowledge section, para. 4) As Shulman (1986, 1987) proposed more than two decades ago, however, content knowledge alone is not sufficient. Teacher knowledge must also encompass disciplinary, general pedagogical, and pedagogical content knowledge. All of these together and in dynamic relationship with each other comprise the "content" of teacher expertise. Shulman's unique contribution to the educational literature on teacher knowledge at the time was his crystallization of the notion of pedagogical content knowledge, or a

> special amalgam of content and pedagogy that is uniquely the province of teachers, their own form of professional understanding…it represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented and adapted to the diverse interests and abilities of learners, and presented for instruction. (1987, p. 8)

Windschitl explains that pedagogical content knowledge is focused upon how *students* understand subject matter, including the developmental appropriateness of and prerequisite understandings necessary to learn particular discipline-related ideas, concepts, and other subject matter. As it complements that developmentally focused understanding, teachers' pedagogical content knowledge (PCK) also encompasses "how to select representations, analogies, and activities" (p. 5) that assist learners' content-related conceptualizations. Hughes (2005, p. 279) explains the use of PCK pragmatically, saying,

> Pedagogical content knowledge is specific for each content area; teachers within a discipline make pedagogical decisions about instruction and learning based on what they believe to be the purpose(s) for teaching the content, what knowledge they believe students should be developing (noting what has been taught in previous and subsequent grade levels), what discipline-based teaching materials are available, and what representations or activities have been successfully used in their past teaching.

Koehler & Mishra (chapter 1) are among a growing number of scholars (e.g., Pierson, 2001; Hughes, 2003; Franklin, 2004; Gunter & Baumbach, 2004; McCrory Wallace, 2004; Irving, n.d.) who have recognized that a particular type of pedagogical content knowledge—that is, *technological* PCK, to use Pierson's term—is what teachers must develop to be able to effectively integrate use of educational technologies into curriculum-based instruction. Though the terms differ somewhat—Gunter & Baumbach, for example, consider this type of PCK to be a form of literacy that they call "integration literacy" (p. 193)--the concepts and constructs across theorists are similar.

It is important to note that technological pedagogical content knowledge (TPCK) is interdependent with content, pedagogical, and technological knowledge; and also pedagogical content, technological content, and technological pedagogical content knowledge, as Koehler & Mishra's diagram and explanations in chapter 1 show. Moreover, each and all of these are influenced by contextual factors, such as culture, socioeconomic status, and organizational structures. Thus, TPCK as it is applied in practice must draw from each of these interwoven aspects, making it a complex and highly situated educational construct—a "wicked problem," as was asserted in chapter 1. Given the nature of this type of problem,

> *There is no single technological solution that applies for every teacher, every course, or every view of teaching.* Quality teaching requires developing a nuanced understanding of the complex relationships [among] technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representations. (Mishra & Koehler, 2006, p. 1029)

The ways in which teacher educators help teachers to develop TPCK and concomitantly integrate educational technology use into their practice should therefore reflect the interdependence of technology, pedagogy, and content, so that knowledge of each aspect is developed concurrently (Cochran, DeRuiter & King, 1993), and is as philosophically, pedagogically, and contextually flexible as Mishra & Koehler recommend.

Experienced teachers' knowledge is situated, event-structured, and episodic. It is "developed in context, stored together with characteristic features of…classrooms and activities, organized around…tasks that teachers accomplish in classroom settings, and accessed for use in similar situations" (Putnam & Borko, p. 13). Attempts to assist experienced teachers' development of TPCK should accommodate these characteristics if more pervasive technology integration is a goal of a particular professional development effort.

There is also some evidence that well-developed TPCK may be positively correlated with general teaching expertise. Though TPCK can be demonstrated at a beginner's level in an experienced teacher with little technology integration expertise, it probably develops more quickly for a seasoned educator than for a teaching intern (Pierson, 2001). Logically, this suggests that TPCK-focused professional development for experienced teachers should be qualitatively different than similar professional learning opportunities for most novices. Koehler & Mishra (2005) demonstrated that TPCK can be developed measurably using a design-based approach in authentic instructional planning contexts. Considering all of these ideas, along with the complex and very situated nature of TPCK, plus the time-strained realities of teachers' schedules, suggests the provision of *flexible design scaffolds* to assist experienced teachers with development and practice of curriculum-based TPCK. These will be described in the next section.

TPCK Structures: "Lead Sheets"

"You don't know what you like, you like what you know.
In order to know what you like, you have to know everything."
-Branford Marsalis

A "lead sheet" is what jazz musicians use to guide performances of a particular song. It's a shorthand musical score, usually containing only the song's melody (also called the "head") and its harmonic progression. Lead sheets are analogous to what practicing teachers use to plan learning activities for their students. Fully itemized lesson plan documents are used more often to help people learn to plan instruction than to support day-to-day instructional interactions in classrooms. Most practicing teachers use shorthand versions of lesson plan documents, which specify essential elements only: the curriculum topics or standards addressed, instructional activities scheduled, special resources and materials needed, and formal or informal evaluation strategies to be used.

One approach to helping teachers learn to plan technology-integrated learning activities – or "performances of understanding" in the Teaching for Understanding framework's terminology

(Wiske, 1998) – focuses upon creating awareness of the range of possible learning activity types, and helping teachers to know how to select and combine these to help students meet content and process standards in ways that are congruent with their differentiated learning needs and preferences. Based upon a metaphorical understanding of Branford Marsalis' statement above, it is only after teachers are familiar with the full range of learning activity types that they can appropriately choose among and effectively implement them in each learning situation. Since content, pedagogy, and technology knowledge are so interrelated and interdependent (Koehler & Mishra, chapter 1), and given the socially situated, event-structured, episodic, and pragmatic nature of experienced teachers' knowledge (Moallem, 1998; Putnam & Borko, 2000), it serves to reason that there are identifiable TPCK-related activity types, within and across curriculum-based disciplines.

There is some evidence that learning activity types – called "activity structures" in social semiotic and science and mathematics education literature –- are cognitive structures that experienced teachers use regularly (albeit subconsciously at times) to plan and carry out instruction. Windschitl (2004), for example, when examining recommended pedagogical practice for science labs, identifies several lab-related activity structures, defining the term as follows.

> The term "activity structure" is borrowed from the sociocultural theorists, meaning a set of classroom activities and interactions that have characteristic roles for participants, rules, patterns of behavior, and recognizable material and discursive practices associated with them. "Taking attendance," "having a discussion," and "doing an experiment" could all be considered activity structures. While the term "activities" refers to specific phenomena occurring in classrooms, the structures underlying these are more general and applicable across multiple contexts. (p. 25)

Polman (1998) sees activity structures operating on both classroom (e.g., whole-group question-and-answer session) and school levels (e.g., academic credit units). He also asserts that, from a sociocultural standpoint, dominant activity structures are cultural tools that perpetuate and standardize interaction patterns—and therefore interaction norms and expectations—primarily according to teachers' memories of dominant discourse patterns from their own school-related childhood experiences. When a paradigmatically new teaching approach is attempted, Polman argues, since there isn't an "obvious set of well-established cultural tools to structure their interaction," (p. 4) the resulting confusion and resistance can undermine reform efforts. It would seem, then, that some activity structures could also represent a mismatch between teachers' and students' differing socioculturally based expectations for teacher-student and student-student interaction (e.g., preferences for competitive or collaborative work on school assignments), and therefore should be selected from as culturally competent a stance as possible. (More on TPCK and cultural competence can be found in chapter 2.)

The notion of activity structure is rooted in the study of classroom-based discourse, with Mehan's (1979) I-R-E (teacher initiation, student reply, teacher evaluation) sequence being the first commonly cited discursive structure in educational literature. Lemke (1987) applied the notion of recurring discourse structure to the social semiotics of science education more broadly, noting that "every meaningful action in the classroom makes sense as part of some recurring semiotic pattern," (p. 219) and that every action has both interactional and thematic meaning. That meaning unfolds, according to Lemke, within two independent discourse structures: activity structures and thematic structures. Activity structures are "recurring functional sequences of actions" (p. 219) and thematic structures are familiar ways of speaking about a topic, such as the curriculum-based focus of a unit or lesson (Windschitl, 2004). Lemke's underlying assertion is that meaning cannot be separated from action; the structure of curriculum content cannot be separated from the structure of content-related learning activities. Given similar underlying assumptions of TPCK's interdependence, it is probable that tool and resource use—both digital and nondigital—can similarly not be separated from content/theme and activity structure. Therefore, TPCK-related activity structures for teachers' use should be conceptualized and presented thematically, in terms of particular disciplinary discourses.

Several educational researchers have begun to examine the intentional cultivation and use of activity structures in professional development for teachers. Kolodner & Gray (2002), for example, proposed a system of "ritualized" learning activity structures to assist learning and teaching in project-based science work. (More on science learning and TPCK can be found in chapter 9.) These authors recommend ritualizing activity structures at both strategic and tactical levels – that is, in terms of sequencing both the steps for participating in a particular type of activity and the ordered succession of activities in a project or unit. Kolodner & Gray's activity structures are specific to the skills that each helps students to develop. For example, there are three different types of presentations included: for experimental results, for ideas, and for experiences with multiple problem solutions. These researchers discovered that, contrary to common expectations that too many different activity structures would overwhelm students and teachers, such fine-grained differentiation actually assists both learners and instructors in knowing what to expect, how to participate in, and how each activity type is connected to the development of content-specific processes. The structures "articulate[ed] and normalize[ed] a sequence of activities and setting expectations about how and when to carry them out." ("Ritualized" Activity Structures section, para. 3)

Polman's (1998) 2-year classroom-based research study sought to document a project-based alternative to the traditional I-R-E activity structure. He discovered a B-N-I-E structure being used in a middle school science class, in which students "bid" by suggesting topics that they would like to research, then "negotiated" the details of the projects based upon those possible topics, then "instantiated" their understanding with work on the project according to their understanding of the instructor's guidelines, then received and considered formative "evaluation" from the teacher on their work. The evaluation results then formed the basis for a new recursion of the B-N-I-E sequence.

Polman's research continued as he then tested the B-N-I-E activity structure in a different discipline: history. He found that the structure could be modified to accommodate an alternate curriculum area, but that the adaptation must involve choices "along the dimensions of act (what) and agency (how)" (p. 22) because the nature of inquiry and expression in different disciplines differ in essential ways—for example, between a lab report and an historical narrative. Polman's work with the same activity structure in two disparate disciplines raises the question of the extent to which activity structures or types are discipline-specific or transdisciplinary. I will address this issue below.

During an in-depth study of science education practices in Japan, Linn, Lewis, Tsuchida, & Songer (2000) compared the presence and use of science activity structures in multiple classrooms, finding them to be consistently present and similarly described by both students and teachers, framed in terms of what students do during each science-related learning experience. The researchers also explored how these activity structures are connected to larger system structures, including teacher professional development. They hypothesized that the highly collaborative nature of Japanese teacher interactions may be a factor determining the consistency of both the structures and discussion of them by teachers and students. Contrary to popular U.S. perceptions, "Japanese teachers ultimately choose the instructional approaches they will use in the classroom," but "shared research lessons may offer opportunities for teachers to collectively build and refine not just instructional techniques, but also norms about what is good instruction." (p. 11) This points to an essential feature of successful use of activity structures as instructional planning/design tools: as Linn et al. recommend, they are best used flexibly and in the context of active teacher discourse communities to "enable deep, coherent instruction." (p. 4)

Dodge's (2001) recommendations to teachers of "five rules for writing a great WebQuest" illustrate what can happen when an activity structure is used without the active professional discourse that Linn et al. suggest. In Dodge's own words,

> A quick search of the Web for the word *WebQuest* will turn up thousands of examples. As with any human enterprise, the quality ranges widely….Some of the lessons that label themselves WebQuests do not represent the model well at all and are merely worksheets with URLs. (p. 7)

Dodge and March (Dodge, 1995) specifically intended for the WebQuest to be an inquiry-based activity that emphasizes students' use of information located online at analysis, synthesis, and evaluation levels primarily. With posted evaluation standards now available and encouraged for teachers' use (Dodge, Bellofatto, Bohl, Casey & Krill, 2001), Dodge hopes that a greater proportion of newly created WebQuests will reflect the purposes for and types of learning originally conceptualized.

My own work with TPCK-based activity structures began as explorations of curriculum-based telecomputing applications for K-12 students (e.g., Harris, 1993; 1995-96; 1998) that were assumed to be cross-disciplinary, like WebQuests. This taxonomy of 24 activity structures, organized into "telecollaborative"--later: "telecollaborative" and "telecooperative" (Harris, 2005; 2007)—and "teleresearch" genres, were embraced by many teachers and teacher educators as a viable way to think about and design curriculum-based learning that integrated appropriate use of online tools and resources. The structures are still in active use today, as a Google search demonstrates.

Table 1: Telecollaborative and Telecooperative Activity Structures
(From: Dawson & Harris 1999, P2)

Genre	**Telecollaborative/ Telecooperative Activity Structure**	**Description**
INTERPERSONAL EXCHANGE	Keypals	Students communicate with others outside their classrooms via email about curriculum-related topics chosen by teachers and/or students. Communications are usually one-to-one.
	Global Classrooms	Groups of students and teachers in different locations study a curriculum-related topic together during the same time period. Projects are frequently interdisciplinary and thematically organized.
	Electronic Appearances	Students have opportunities to communicate with subject matter experts and/or famous people via email, videoconferencing, or chatrooms. These activities are typically short-term (often one-time) and correspond to curricular objectives.
	Telementoring	Students communicate with subject matter experts over extended periods of time to explore specific topics in depth and in an inquiry-based format.
	Question & Answer	Students communicate with subject matter experts on a short-term basis as questions arise during their study of a specific topic. This is used only when all other information resources have been exhausted.
	Impersonations	Impersonation projects are those in which some or all participants communicate in character, rather than as themselves. Impersonations of historical figures and literary protagonists are most common.
INFORMATION COLLECTION AND ANALYSIS	Information Exchanges	Students and teachers in different locations collect, share, compare and discuss information related to specific topics or themes that are experienced or expressed differently at each participating site.
	Database Creation	Students and teachers organize information they have collected or created into databases which others can use and to which others can add or respond.
	Electronic Publishing	Students create electronic documents, such as Web pages or word-processed newsletters, collaboratively with others. Remotely-located students learn from and respond to these publishing projects.
	Telefieldtrips	Telefieldtrips allow students to virtually experience places or participate in activities that would otherwise be impossible for them, due to monetary or geographic constraints.
	Pooled Data Analysis	Students in different places collect data of a particular type on a specific topic and then combine the data across locations for analysis.

PROBLEM SOLVING	Information Searches	Students are asked to answer specific, fact-based questions related to curricular topics. Answers (and often searching strategies) are posted in electronic format for other students to see, but reference sources used to generate the answers are both online and offline.
	Peer Feedback Activities	Students are encouraged to provide constructive responses to the ideas and forms of work done by students in other locations, often reviewing multiple drafts of documents over time. These activities can also take the form of electronic debates or forums.
	Parallel Problem Solving	Students in different locations work to solve similar problems separately and then compare, contrast, and discuss their multiple problem-solving strategies online.
	Sequential Creations	Students in different locations sequentially create a common story, poem, song, picture or other product online. Each participating group adds a segment to the common product.
	Telepresent Problem Solving	Students simultaneously engage in communications-based realtime activities from different locations. Developing brainstormed solutions to real-world problems via teleconferencing is a popular application of this structure.
	Simulations	Students participate in authentic, but simulated, problem-based situations online, often while collaborating with other students in different locations.
	Social Action Projects	Students are encouraged to consider real and timely problems, then take action toward resolution with other students elsewhere. Although the problems explored are often global in scope, the action taken to address the problem is usually local.

Table 2: Teleresearch Activity Purposes (From Harris, 1998)

Genre	Teleresearch Activity Purpose	Process Description
TELERESEARCH	Hone information skills	Practicing information-seeking and information-evaluating skills.
	Explore a topic or answer a question	Exploring a topic of inquiry or finding answers to a particular question.
	Reviewing multiple perspectives	Discovering and investigating multiple beliefs, experiences, etc. upon a topic.
	Generate data	Collecting data remotely.
	Problem-solving	Using online information to assist authentic problem-solving.
	Teleplant/telepublish	Publishing information syntheses or critiques for others to use.

TPCK Structure Combinations: "Fake Books"

"Imitate, assimilate, and innovate."

- Clark Terry

In using this first activity taxonomy to design curriculum-based learning experiences for and with students, I encouraged teachers to combine activity types, digital and nondigital tools used, and curriculum standards. Yet as the years passed and access to hardware, software, and technology-related professional development improved in many schools, my work with teachers began to suggest that learning activity structures should no longer be classified, even in part, by technology type. To do so, I realized, was technocentric and therefore unnecessarily limiting.

In a reconceptualization of activity structures as "activity types" (Harris & Hofer, 2006)--a term that seems to be preferred by many teachers—it is possible to combine the advantages of using design-based conceptual tools for planning, this time differentiated by curriculum area, while considering the full range of educational technologies available. Using this particular approach to professional development in technology integration, teachers learn to recognize, differentiate, discuss, select among, combine, and apply TPCK-oriented activity types in curriculum standards-based instructional design. In this way, teachers can function as designers in time-efficient ways that accommodate the nature of their daily schedules, which unfortunately don't allow sufficient opportunities for as much in-depth design-based planning as teachers may wish to do, or as teacher educators may recommend.

Social studies is the first curriculum area for which my colleague and I have developed a taxonomy of TPCK-related activity types that can be supported by a full range of digital and nondigital tools and resources. (For information on TPCK and social studies beyond learning activity design, please see chapter 6.) Twelve examples of these 40 activity types are described below. The group is divided into 15 knowledge-building and 25 knowledge expression social studies-based activity types. Knowledge expression activity types are further divided into activities that emphasize either convergent or divergent thinking processes.

Knowledge-building activities are those in which students build content-related understanding through information-based processes. Five knowledge-building activity types follow. In the *view images* activity type, digital and/or nondigital images can be used to reinforce readings or points made in class presentations, provide a different and complementary means to present content, and/or generate reactions and discussion. In an *artifact-based inquiry* activity, online archives of artifact reproductions—such as primary source documents--provide students with a focused set of resources around a particular historical topic of interest, such as the Boston Massacre, the Holocaust, or Brown v. The Topeka Board of Education. These resources can then be used in a number of ways, encouraging students to ask questions of interest, while providing resources rich enough for them to begin to find answers. In developing an *historical chain*, students explore and then sequence documents (text, images, maps, etc.) in chronological order, using clues found within the documents. This challenges the students to carefully examine the documents, apply their knowledge of their historical contexts, and make inferences about how the documents may be justifiably combined. By contrast, in an *historical weaving*, students explore multiple historical documents or other resources concerning a person, place, or event, and piece them together into an integrated narrative. This activity goes beyond an historical chain in that it is not necessarily just a linearly structured story. An historical weaving may contain multiple chains of events happening simultaneously, challenging students not only to sequence events, but also make connections among these parallel stories. The challenge of this activity type requires students to understand, sequence, and synthesize events to tell the story of what may have happened. By contrast, in an *historical prism* activity, students compare & contrast multiple historical sources representing different perspectives upon a particular person, place or event. This type of work often involves students stepping outside their comfort zones and reconciling divergent--if not contradictory--viewpoints.

Knowledge expression activity types help students to deepen their understanding of content-related concepts through various types of communication. **Convergent** knowledge expression activities, such as *completing charts or tables* based upon a classroom lecture or discussion, content-based reading, or as a synthesis activity after careful review of multiple sources, help students to take information and summarize it in another form. Charts, tables and other graphic organizers can be projected for whole-group discussion/analysis using anything from printed overhead transparencies to editable digital documents that can be updated extemporaneously. Blank charts and tables created by the teacher also can be provided to students to complete in paper-based or electronic forms. Alternatively, to help students to express their understanding of historical cause and effect, creating cognitive contexts for complex events or topics, they can *create a timeline*. Whether in history, government, economics, or even sociology, when students sequence information, people, and events on a timeline, they can see connections and chronology much more clearly than when relying exclusively upon paragraphed text. While timelines can be and are created with paper and pencil, students can also use Web authoring or multimedia presentation software to create interactive timelines in which the dates or entries are linked to additional pages or slides that provide more detailed information about each.

Divergent knowledge expression activities in social studies help students to extend their content-related understanding via alternative forms of communication. For example, as an alternative to writing a report, *developing a presentation* enables students to share their understanding of a topic or concept using their own voice and a variety of visual or audio aids. The presentation may be given in either a formal or more casual way; either individually or with a small group; either face-to-face or "packaged" in some way to allow viewers to explore the presentation on their own. Another activity type that helps students to make abstract social studies concepts more accessible is *building a knowledge web* of the interconnected components of an idea, issue, occurrence or concept being studied. Developed as a class, in small groups, or individually, the creation and use of webbed graphic representations of complex topics and concepts can help students to develop questions and understanding beyond what is presented more didactically in textbooks and similarly structured instructional materials.

Other **divergent knowledge expression activity types** help students and teachers to use educational technologies in ways that go beyond digitally enhancing traditional knowledge expression methods. Three of these activity types are described here. For example, films--rich and engaging stories leveraging visuals, sound, and music--are significant and ubiquitous artifacts of modern culture. Proponents of positioning students as filmmakers assert that students approach storytelling and writing in very different ways when multimedia options for expression are available. When students *create their own films* related to course content, their unique voices can be heard in diverse and rich ways that simply are not possible in written or oral forms of expression. Another divergent knowledge expression activity type--the *historical impersonation*--takes the historical diary assignment to another level. Using this approach, students are challenged not only to understand the past through the eyes of a particular person; they actually "become" the person and either make an oral presentation in first-person or interact with others—face-to-face or online--using the voice of an actual or historically possible figure from the past. Impersonating an historical figure challenges students to develop a rich understanding of a person's temporal context, experience and viewpoints. Finally, when tied to coursework, *engaging in civic action* is active and purposeful, and can be transformative for students and their understanding of what it means to be a citizen, both locally and globally. Use of global, multimodal information networks helps students to not only learn about distant communities; but also to connect with people from around the world, making new and numerous civic action opportunities easily accessible. Through email exchanges, discussion forum conversations, and desktop video conferencing, students can share local information and perspectives, connecting with and learning from people around the world, thus expanding their notions of both citizenship and community.

Note that each of these example activity types, as they have been described here, do not typically privilege one particular type or class of educational technology. The same is true for the nascent research in developing and applying curriculum-based activity types done by other researchers and mentioned earlier in this chapter. Rather, in identifying and sharing activity types, the intention is to help teachers to become aware of the full range of possible curriculum-based learning activity options, and the different ways that digital and nondigital tools support each, so that they can select among, customize, and combine activity types that are well-matched to both students' differentiated learning needs and preferences, and contextual realities, such as computer access and class time available for learning activity work. Using this design approach, as teachers plans classroom-based learning experiences, they keep students' needs, preferences, and relevant past experience in front-and-center focus, with curriculum standards and possible activity type selections in close visual peripheries, so that all are considered concurrently, albeit with differing emphases at different times and under different conditions.

Yet experienced teachers' planning for students' learning is not an activity-by-activity endeavor. Curriculum-based units, projects, and sequences are much more than the sums of their respective parts. Analogously, jazz "fake books" are collections of "lead sheets" that jazz musicians use to improvise a night's performance. In this sense, "faking" is jazz improvisation, with minimal but essential pre-performance notation recorded for the musicians to use as a guide—like most experienced teachers' lesson plans. Following through with this metaphor, if lead sheets are realistic lesson or learning activity plans based upon riffs as learning activity structures/types, then when lead sheets are combined into fake books, metaphorically they form the basic plans for longer-term educational projects and units of study. Part of what a curriculum-based activity types approach to the development of TPCK addresses is how to combine individual activity types into engaging, appropriate, and authentic project or unit plans.

For many experienced teachers, selecting, adapting, and designing learning activities, projects, and units is review work, but the awareness of how different digital and nondigital tools can be used in service of students' learning within each of the activity structures/types encompasses new information and/or new ways of thinking about the planning/instructional design process. Like jazz, much of experienced teachers' work is context-dependent, serendipitous improvisation, but it still follows a predetermined, somewhat predictable structure. Some jazz improvisationalists compose music of their own--as some teachers prefer to design and implement original projects and lessons--and others base their work completely upon their own interpretations of others' songs. It is important that professional development for experienced teachers that emphasizes TPCK be flexible enough to accommodate the full range of teaching philosophies, styles, and approaches. One way to ensure that flexibility is to share the full range of curriculum-based activity types within each discipline area, encouraging experienced educators to select among them based upon perceived appropriateness and advantage – and to engage in this selection/combination process each time a new lesson, project or unit is planned.

TPCK and Relative Advantage

"It's taken me all my life to learn what not to play."
-- Dizzie Gillespie

Knowles and his colleagues (e.g., Knowles, Holton & Swanson, 1998) remind us that to be effective, adult education must operate according to a completely different set of principles than instruction of children and adolescents. Knowles stresses the importance of andragogical, rather than pedagogical approaches. Andragogical principles are especially important to keep in mind when planning and providing professional development for experienced teachers.

Andragogical assumptions suggest that adults need to know why they should learn something, and how, if at all, it will benefit them directly. They "resent and resist situations in which they feel others are imposing their wills on them," (Knowles et al., 1998, p. 65) and respond better to learning if their past experience and expertise can be acknowledged and used in the present learning act. Adults prefer authentic learning, in which direct ties to particular tasks, problems, or similarly real-life situations are made. Adults are motivated more internally, rather than externally, to learn, and become ready to do so when "they experience a need to learn…in order to cope more satisfyingly with real-life tasks or problems." (Knowles, et al., 1998, p. 44) Yet in spite of a preference for autonomy, many adult learners – experienced teachers included – are accustomed to more dependent forms of learning.

For all of these reasons, TPCK-related professional development for experienced teachers should promote both autonomous and collaborative instructional decision-making while simultaneously encouraging open-minded consideration of new instructional methods, tools, and resources. Activity types that are keyed directly to required curriculum standards can provide both flexible scaffolding and authenticity of purpose for experienced teachers' TPCK-related learning – a balance of helpful, non-constraining structure/scaffolding for new implementation ideas while acknowledging experienced teachers' agency and expertise in the classroom.

Ultimately, each teacher will decide the relative advantage (Rogers, 2003) – and therefore the probability of use – of each unfamiliar TPCK-related instructional design idea. As Zhao & Cziko (2001) remind us, teachers are "goal-oriented, purposeful organisms" (p. 6) who will choose actively *not* to integrate use of educational technologies if they do not recognize the need to do so—even if access and support for technology integration are readily available. In practical terms, each new instructional possibility is assessed by each teacher using an implicit equation: utility = value / effort (Fischer, 2002). Approaching experienced teachers andragogically, rather than pedagogically, acknowledges the reality of this dynamic. TPCK-related professional development for experienced teachers is, after all, more a process of persuasion than prescription.

Given these recommendations, a final underlying issue should be addressed. In her literature review about issues of scale in school reform efforts, Coburn (2003) states:

> Because teachers draw on their prior knowledge, beliefs, and experiences to interpret and enact reforms, they are likely to "gravitate" toward approaches that are congruent with their prior practices…, focus on surface manifestations rather than deeper pedagogical principles…, and graft new approaches on top of existing practices without altering classroom norms or routines. (p. 4)

As described in this chapter and as recommended by Mishra & Koehler (2006), an activity structures/types approach to TPCK-focused professional development for experienced teachers does not preference any particular teaching philosophy or approach. In not doing so, it is probable that teachers learning to use TPCK-based design scaffolds will more often assimilate--as Coburn suggests,--comparatively familiar activity types and combinations, rather than accommodate existing teaching ideas and approaches to use more unfamiliar activity types in ways that demonstrate and exemplify deep philosophical change.

Does this present a challenge to be addressed? Perhaps – but only if the goal of a particular professional development effort is qualitative philosophical change in teachers' beliefs and practices. To accomplish a goal of better or more extensive *technology integration* does not necessarily require a philosophically transformative agenda for professional development. Instead, the primary goal of such professional learning and reflection could be to develop and act upon TPCK in and to whichever forms and extents experienced teacher practitioners choose. Though it is necessarily a topic for a different chapter, it bears mention here that the automatic coupling of methodological and philosophical reform in current-day educational technology professional development efforts—such as was demonstrated in the much-publicized ACOT research (Sandholtz, Ringstaff, & Dwyer, 1997)--may be ill-advised if technology integration/TPCK development is the primary goal of a particular professional development program.

After all – as in jazz music, there are many different styles and traditions of teaching in which experienced teachers situate themselves via their practice. There are different styles of jazz (e.g., Dixieland, swing, big band) and jazz combines with other musical genres (e.g., blues, classical, hip-hop) just as there are different styles of teaching, which often borrow from and fuse with work in multiple disciplines. In the end, if students' differentiated curriculum-based learning needs and preferences are being accommodated well, it is both a practical and an ethical imperative to support and respect—in addition to helping to inform-- experienced teachers' pedagogical choices. To assume that a particular instructional approach is privileged by educational use of digital technologies is as silly as assuming that a guitar should only be used to play the blues, or a pianist should only attempt ragtime. The development of pedagogical approaches, like the development of jazz traditions, is an additive, recursive, and expansive process, rather than a linear series of replacements of "old" with "new." Experienced teachers learning to develop and apply technological pedagogical content knowledge is an essential aspect of that expansion.

"One of the things I like about jazz, kid,
is I don't know what's going to happen next. Do you?"
-- Bix Beiderbecke

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